

AEROMEDICAL REVIEWS

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TO CHRONIC RECURRENT AEROTITIS MEDIA

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**THE VALSALVA MANEUVER: ITS RELATIONSHIP
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Aerotitis media is a medical problem that has been associated with flight since man first took to the skies. In the latter part of the eighteenth century, one of the early French balloonists reported severe ear pain during flight, but it was not until World War II and the advent of high-performance aircraft that the condition gained clinical significance. The problem has financial significance as well; it is now estimated that training a combat-ready aircraft commander in the Strategic Air Command costs \$300,000 (1). The cost will be even more as aircraft become more complex. It is, therefore, imperative that the Air Force use effective screening procedures prior to flight training to detect any physical condition in the candidate which might impair aircrew effectiveness. Aerotitis media is a condition which usually requires grounding of flight personnel for about four days following an acute episode (2). Chronic recurrent aerotitis, while rare, can result in permanent grounding.

Armstrong (3) introduced the term *aerotitis media* in 1937 and defined it as "an acute or chronic traumatic inflammation of the middle ear caused by a pressure difference between the air in the tympanic cavity and that of the surrounding atmosphere. It commonly occurs during changes of altitude in airplane flights and is characterized by congestion, inflammation, discomfort, and pain in the middle ear and a temporary impairment of hearing. Aerotitis media is caused by inadequate ventilation of the middle ear during ascent or descent in flight." This definition satisfactorily explains the condition and is accepted today. Several investigators, Campbell (4), Dickson (5), Stewart (6), and Wright (7), have shown that aerotitis media most often occurs during descent. This fact can be explained by the flutter-valve

action of the eustachian tube. During ascent, the air contained in the tympanum expands. This forces the eustachian tube open and the excess pressure in the middle ear is "bled off." This process is entirely passive. On descent, however, the normal closure of the tube becomes even more pronounced and must be opened by voluntary muscular activity. It is generally accepted that aerotitis media does not develop when voluntary precautions are taken to equalize pressure in the middle ear. Inadequate ventilation of the middle ear on descent may be due to failure, or inability, to voluntarily open the eustachian tube. One generally accepted way of equalizing the pressure is by performing the Valsalva maneuver.

VALSALVA MANEUVER

The Valsalva maneuver is named for the Italian anatomist Antonio Maria Valsalva (1666-1723), who first described the procedure: "It is performed by holding shut both sides of the nose and mouth and blowing out the cheeks with forcible expiration" (8). This causes an increase in the air pressure in the posterior nasal space and forces air up both eustachian tubes, inflating the middle ear cavities and producing a bulging movement of the tympanic membranes. The movement is most noticeable in the posterior superior quadrant of the ear drum and can be readily seen through the external canal.

For many years the Air Force has utilized the Valsalva maneuver, along with other procedures, as a screening device to detect those cadet applicants who, normally, would be unable to ventilate the middle ear and who might, as a result, develop repeated episodes of aerotitis media. Since this requirement (AFR 160-1, paragraph 93b(20)) eliminates some candidates who meet all other requirements, it was considered desirable to re-examine the usefulness of a screening procedure requiring Valsalva capability.

It would be ideal to study two groups of cadet applicants: those capable of performing the Valsalva maneuver (ventilators) and those unable to perform it in the usual screening procedure

(nonventilators). In this situation, both groups would be admitted to flying training, and all occurrences of aerotitis media among them would be carefully charted. Although some nonventilators might find other means of inflating the middle ear during pressure changes, or perhaps would eventually learn to perform the Valsalva maneuver, it is probable that a sizable proportion of the group would remain unable to inflate the ears and would subsequently develop chronic recurrent episodes of aerotitis media. This plan is, of course, impractical. A modified version might be attempted in the altitude chambers throughout a number of altitude flights, but this in itself presents danger to the subjects.

The current study has adopted a different approach to the problem. The rationale for this study is based on the assumption that flight personnel who have accrued many hours of flying time have not suffered chronic recurrent attacks of aerotitis media, since otherwise they would have been removed from flying status (AFR 160-1, paragraph 93b(20)). If in a group of experienced flight personnel many were found unable to perform the Valsalva maneuver, then we might conclude that such ability has little relation to recurrent attacks of aerotitis media. On the other hand, if nearly all members of an experienced flying group were found able to perform the Valsalva maneuver satisfactorily, it might support the hypothesis that such ability contributes strongly to freedom from chronic, recurrent, traumatic inflammation of the middle ear. Accordingly, the following procedures were carried out.

PROCEDURES

Testing was conducted for pilots who were undergoing transition to the T-33 aircraft and who had flown many hours in conventional aircraft. This group was selected because they were available and because they were assumed to be free of chronic, recurrent aerotitis media as discussed above. Subjects were examined immediately before entering a pressure chamber for high-altitude indoctrination. While in a standing position, each subject was told to carry out the Valsalva maneuver by occluding the nostrils with his fingers and forcibly exhaling. No time was

available for obtaining case history information from the subjects. In all subjects, the right ear was examined first and then the left.

The total group, examined over a nine-month period, contained 107 pilots. Approximately 10 subjects were examined at each pressure chamber run. They were instructed individually; there was no opportunity to practice the maneuver before the examination, and only one attempt to Valsalva was permitted. Seven members of the group were discarded because excess cerumen prevented adequate visualization of one or both tympanic membranes. For the remaining 100 members, examination of the drum was carried out under magnification with the standard Air Force otoscope.

The criterion for successful performance of the Valsalva maneuver was an observable movement or bulging of the tympanic membrane in both ears. Because the fullness of the middle ear tends to subside with elapsed time, the effects observed in the right ear (examined first) were expected to be greater than those in the left. Determination of a successful Valsalva performance always demands an element of judgment on the part of the examiner. In this study, the same physician performed all examinations. The criterion was applied as objectively as possible in view of the current clinical procedure.

RESULTS

Of the 100 pilots tested, 5 were unable to ventilate the middle ear by the Valsalva maneuver. In 3 subjects no motion could be detected in either tympanic membrane, while in the remaining 2 subjects some motion was evident in one drum. All 5 appeared to attempt to carry out the procedure in the prescribed manner. No scarring of the ear drums of any member of this group was evident, nor was other evidence of acute or chronic pathology observed during the brief otologic examination which would interfere with the Valsalva maneuver.

The remaining 95 subjects, using the Valsalva technic, were able to produce definite movement of both tympanic membranes.

Among the successful subjects, varying degrees of motion of the tympanic membrane were observed. In some, the entire drum bulged with little effort; others had to exert more pressure. In all instances the deflection was definite enough that a trained examiner would not question it.

The finding that 95 of the 100 experienced pilots—assumed to be free of chronic recurrent aerotitis media—performed the Valsalva maneuver successfully in both ears supports the proposition that ability to Valsalva is a desirable screening requirement. From these data it cannot be concluded that those unable to perform the Valsalva maneuver will develop recurrent, traumatic inflammation of the middle ear; however, there is rather striking evidence that subjects not suffering from this condition are able to perform the maneuver satisfactorily.

REVIEW OF RECORDS

To obtain additional information on this subject, a review was made of records of patients who had been seen in consultation at the School of Aerospace Medicine since 1954 and who were diagnosed as having chronic, recurrent aerotitis media. The condition in 6 of these could not be explained on the basis of nasal allergy, lymphoid hyperplasia of the nasopharynx, dental abnormality, or other specific demonstrable defect. The records indicated that 5 of these 6 patients were unable to carry out the Valsalva maneuver or did so only with great difficulty, even at ground pressure levels. Although the sixth could Valsalva during examination on the ground, he developed severe ear pain on ascent in the chamber. This was unusual, since aerotitis media characteristically develops on descent. This particular individual was taken to altitude in the low-pressure chamber and on ascent the symptoms characteristic of aerotitis media developed. The left tympanic membrane was observed to be tense and full. On descent, the symptoms went away. After myringotomy, the symptoms did not recur on either ascent or descent. It was thought possible that this patient had a ball-valve-type obstruction in the eustachian tube which interfered with the escape of air from the middle ear

on ascent. Although the number of patients with chronic, recurrent aerotitis media examined by this organization in the past six years is admittedly small, the fact that 5 were unable to Valsalva supports the contention that inability to perform the Valsalva maneuver makes likely the development of recurrent, traumatic middle ear inflammation.

AIR FORCE IMPLICATIONS

In view of these findings and the experience of physicians at the School of Aerospace Medicine (Ear, Nose, and Throat Branch), it is recommended that the Valsalva technic be utilized for determining ability to inflate the middle ear as required in Air Force Regulation 160-1. (This recommendation was submitted by this branch to the Office of the Surgeon General in 1957, when revisions in AFR 160-1 were being solicited.) Student flight surgeons in training at this organization are currently taught the technic.

When examining an applicant for flying status, the flight surgeon should remember that although most people can perform the Valsalva maneuver with minimal instruction, some require patient assistance, encouragement, and instruction. Teed (9) found 20 to 30 percent of an unselected group to be unable to Valsalva satisfactorily on the initial attempt. The first effort is frequently hindered by tenseness or apprehension. Initially, the subject may blow fiercely and puff out his cheeks with no results, whereas after relaxation a gentle puff produces the desired result. Even with adequate training a few individuals never master the technic. These are the people who need to be identified in the selection process. The flight surgeon should never assume that a cadet applicant or a patient fails to Valsalva only because he has a cold, is tense, or suffers from some other temporary condition. Retesting and training should be conducted at a later date. If the individual, after adequate time and effort, cannot produce observable drum movement, he should not be permitted to undertake a flying career.

During the portion of the physical examination which concerns Valsalva capability, the eustachian tube must never be far from the examiner's thoughts. In the final analysis, it is not the ear drum or middle ear structures which cause aerotitis media, but an abnormality of the pharyngo-tympanic tube which prevents adequate ventilation of the middle ear. Many otologic disorders involve the eustachian tube. Macbeth (10) has stated, "the assessment of all varieties of deafness in the consulting room and the successful achievement of every operation designed to improve hearing, including those for congenital malformation, demand atmospheric pressure in the middle ear cavity." While the Valsalva technic would seem to be adequate as a routine procedure for preflight screening, other and more reliable tests of eustachian tube function need to be developed for general otologic use in the Air Force.

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